



The Minor Planet Center and the International Asteroid Warning Network

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Outline



- The Minor Planet Center (MPC): Charter and responsibilities
- Quick-and-dirty observation processing tutorial, including world's most confusing set of flow charts
- Discussion of handling possible short-term impacts
- International Asteroid Warning Network information
- the future of surveys



MPC Roles and Responsibilities

The MPC is the world's nerve center for minor planet and comet observations.

The MPC collects, processes, distributes all positional measurements, orbits, and discovery information for all minor planets and comets (and some satellites of planets as well)

We alert the world of impending impacts

We help coordinate worldwide observers





The MPC's Many Hats

Operated at the Harvard-Smithsonian Center for Astrophysics; MPC folks belong to Smithsonian Astrophysical Observatory.

Granted authority for operation by IAU

Fully funded by NASA grants since 2008

all MPC staff non-federal trust-fund indefinite SAO employees, all scientists and IT specialists (everyone has PhD, CompSci degree, or both)



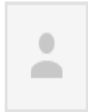
So how does the whole process start?



!!ANGRY NEW NEO!!!!



DISCOVERIES x



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2/27/00



to Catalina, John, Steve, mpc ▾

COD 703

TEL 0.41m f/3 Schmidt + CCD

NET USNO-SA2.0

MEA T. B. Spahr

OBS T. B. Spahr

ACK 0D2837.NEO

0D2837	C2000 02 27.30959 11 21 37.88 +02 29 43.5	17.0 R	703
0D2837	C2000 02 27.32589 11 21 34.50 +02 29 37.5	16.8 R	703
0D2837	C2000 02 27.34198 11 21 31.11 +02 29 31.0	16.9 R	703
0D2837	C2000 02 27.35806 11 21 27.71 +02 29 24.9	17.0 R	703



MPC Observation Processing



Incoming Observations
(survey, follow-up amateur)

Incoming potential NEO
(trusted sources)

FORMAT CHECK;
duplicate check

PUBLICATION CHECK

GCM CHECK

#'d & multi-opp check

one-opp check

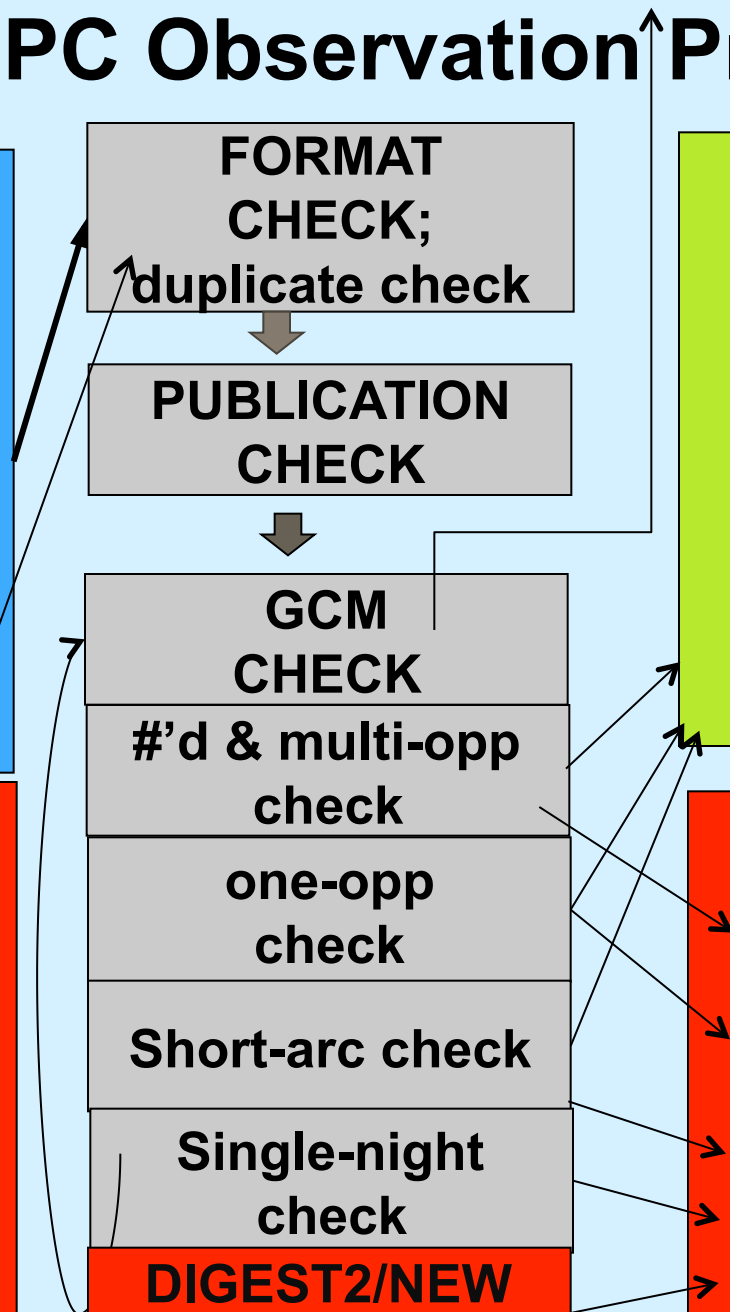
Short-arc check

Single-night check

DIGEST2/NEW NEO??

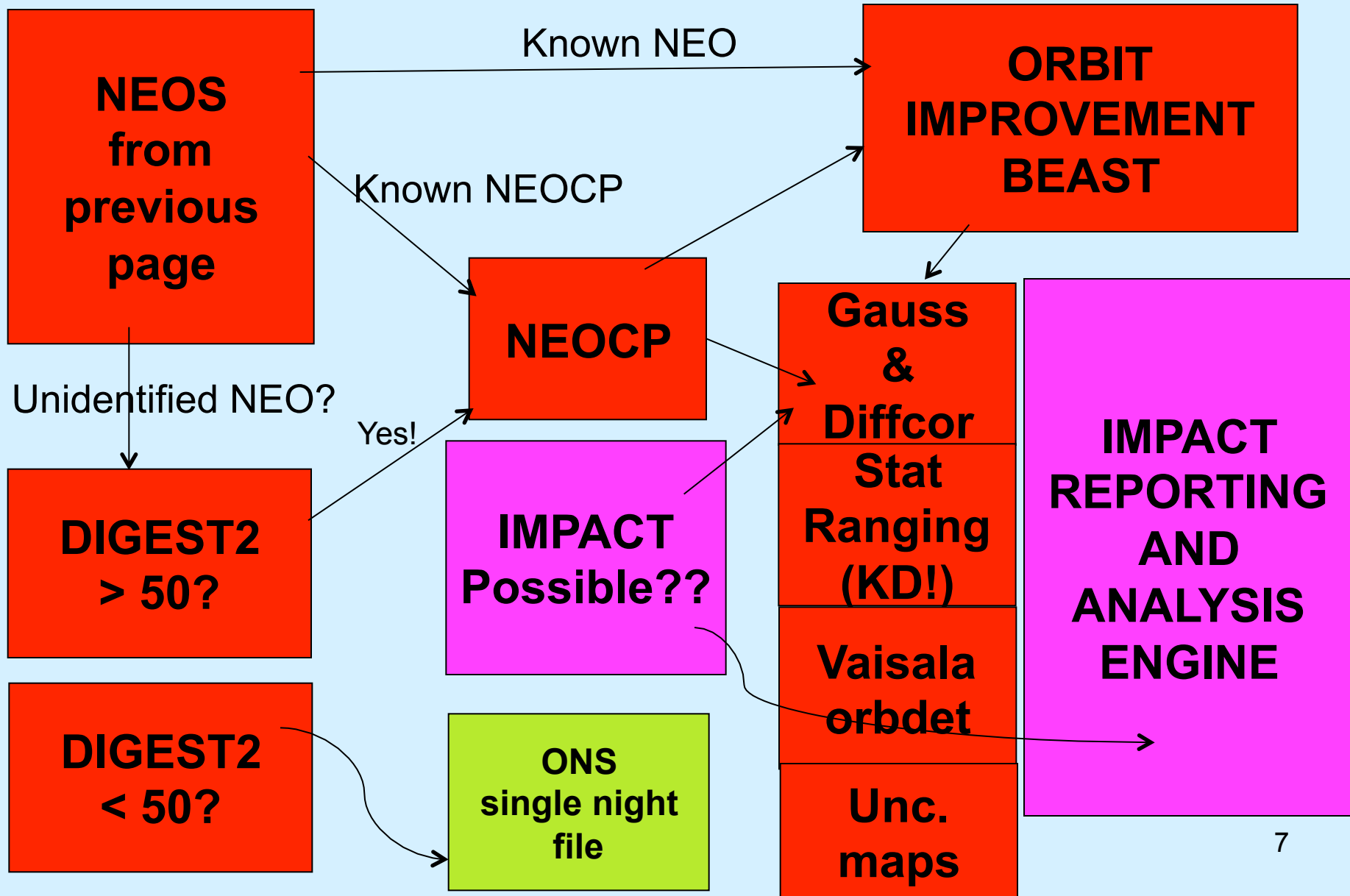
Routine orbit computation beast
(1xx cores; supercomputer)

NEO PROCESSING BEAST
(dedicated cores)



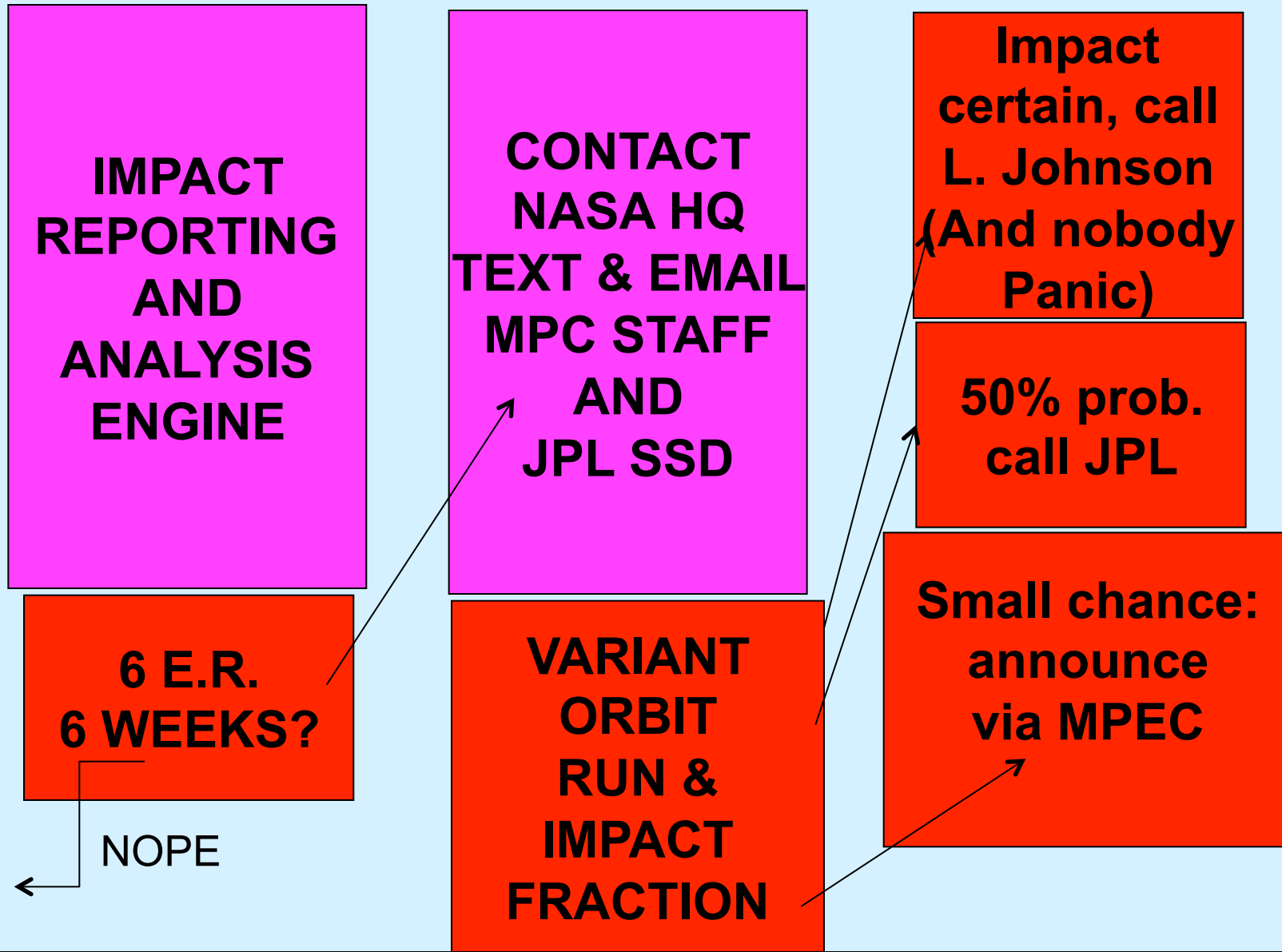


NEO Observation Processing!!





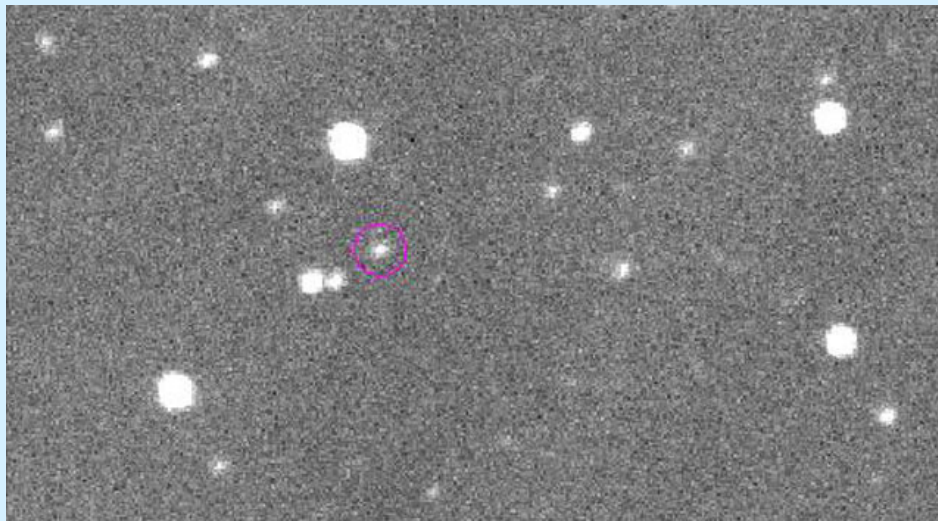
POSSIBLE IMPACT REPORTING & PROCESSING



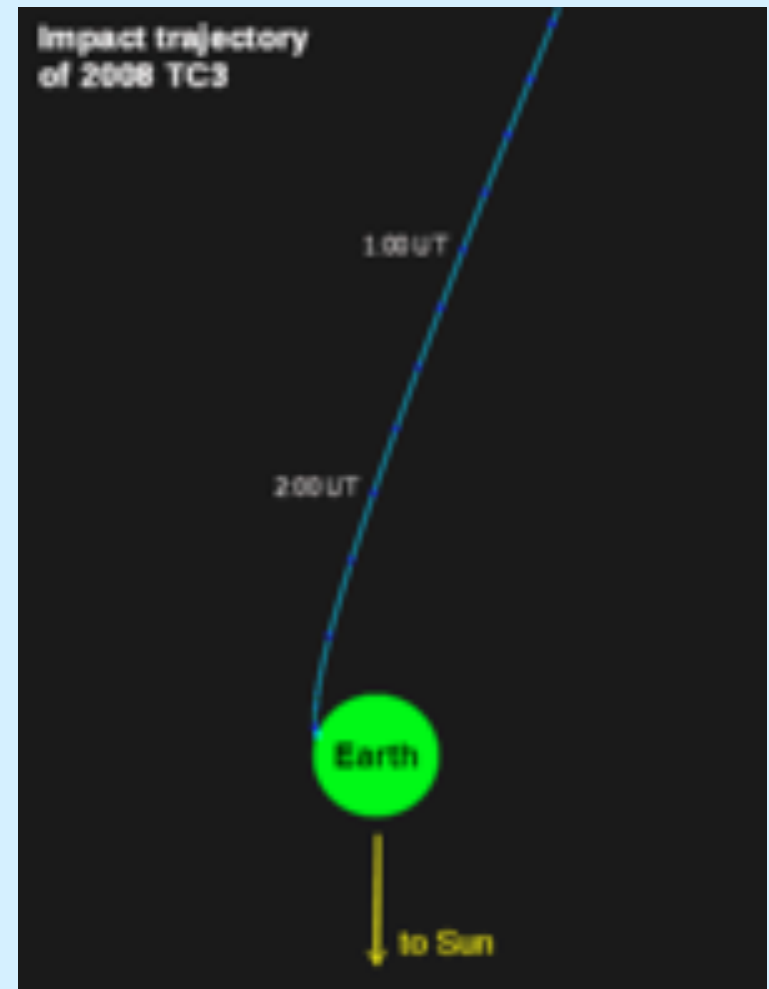


Notes on impacting objects

We've actually already detected an impacting object on the final approach! 2008 TC₃, discovered by Richard Kowalski of the CSS



M.H.Shaddad

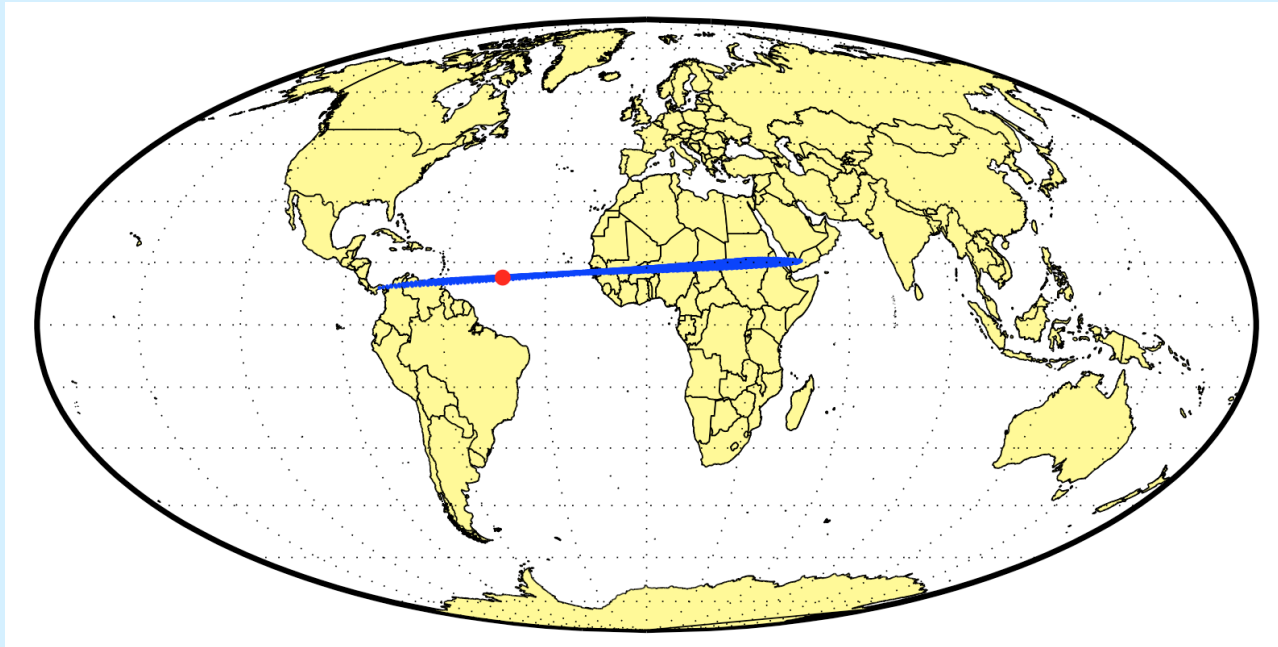


JPL



Notes on impacting objects

2014 AA was also discovered prior to impact, but the holiday interrupted orbital calculations (the entire MPC staff was out at New Year's Eve celebrations)



Brown & Chesley

Also found by Kowalski—apparently he's got a thing for impacts! 10



Some notes on data flow

--We are required to keep up in real time. No sense warning of impacts a day late.

->99% of incoming obs are routine main-belt asteroids (MBAs)!

--NEOs can and do hide with MBA-like motions

-average a few million 'publishable' observations per month

--a good night can see 200,000 obs

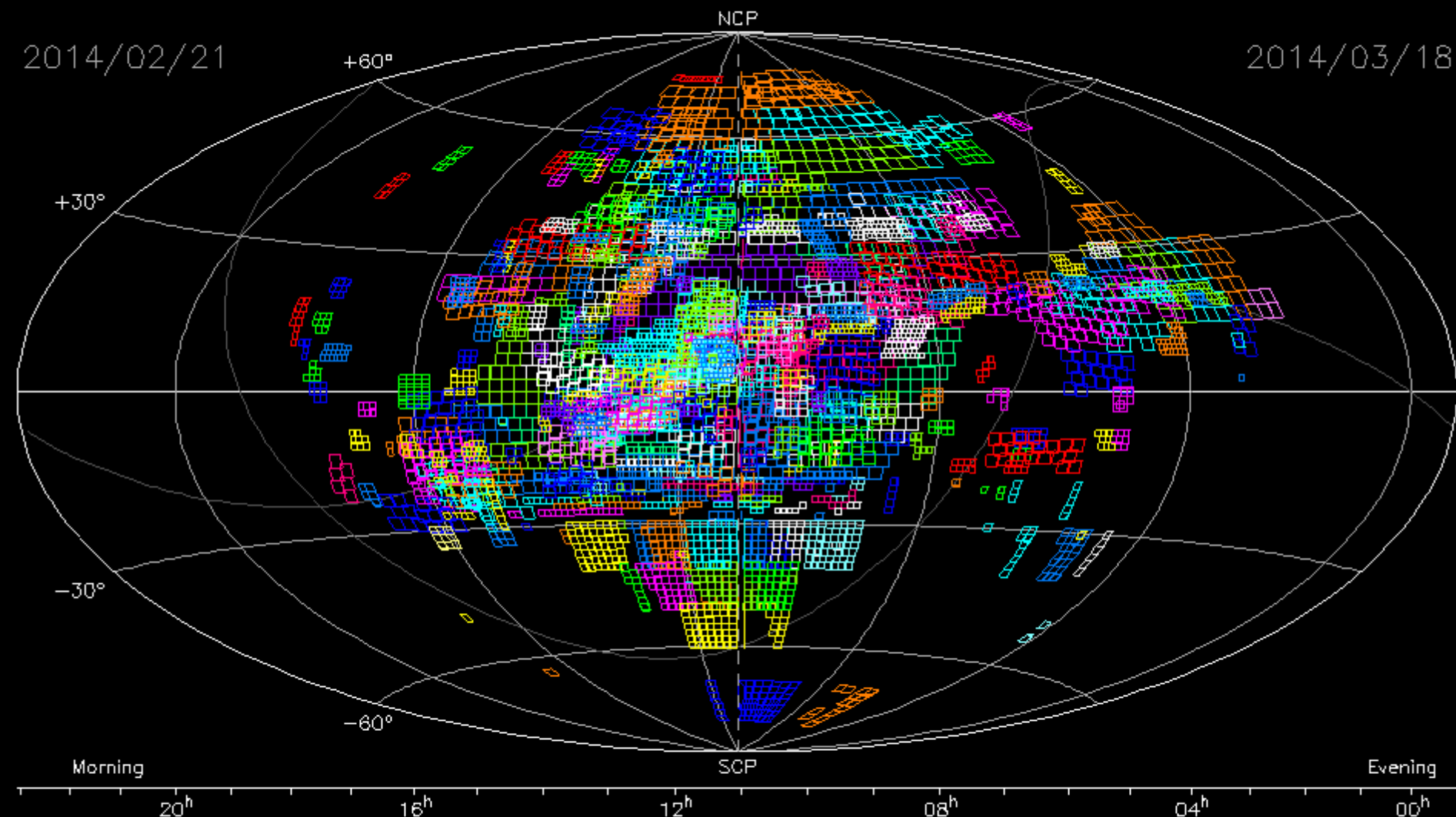
--CSS, MLS, Pan-STARRS: The rest small bits

SKY COVERAGE

Plot prepared 2014/03/18.972 by the Minor Planet Center

2014/02/21

2014/03/18



Morning

Evening

20^h

16^h

12^h

08^h

04^h

00^h

Opposition Point = 11 03.4,+06 03. Fields reaching fainter than $V = 18.0$.

2014/03/18 (2014 077)	2014/03/17 (2014 076)	2014/03/16 (2014 075)	2014/03/15 (2014 074)	2014/03/14 (2014 073)
2014/03/13 (2014 072)	2014/03/12 (2014 071)	2014/03/11 (2014 070)	2014/03/10 (2014 069)	2014/03/09 (2014 068)
2014/03/08 (2014 067)	2014/03/07 (2014 066)	2014/03/06 (2014 065)	2014/03/05 (2014 064)	2014/03/04 (2014 063)
2014/03/03 (2014 062)	2014/03/02 (2014 061)	2014/03/01 (2014 060)	2014/02/28 (2014 059)	2014/02/27 (2014 058)
2014/02/26 (2014 057)	2014/02/25 (2014 056)	2014/02/24 (2014 055)	2014/02/23 (2014 054)	2014/02/22 (2014 053)
2014/02/21 (2014 052)				



How does the MPC communicate?



What is the Minor Planet Center?

The Minor Planet Center, or MPC, is the single worldwide location for receipt and distribution of positional measurements of minor planets, comets and outer irregular natural satellites of the major planets. The MPC is responsible for the identification, designation and orbit computation for all of these objects. This involves maintaining the master files of observations and orbits, keeping track of the discoverer of each object, and announcing discoveries to the rest of the world via electronic circulars and an extensive website. The MPC operates at the Smithsonian Astrophysical Observatory, under the auspices of Division F of the International Astronomical Union (IAU).

[READ MORE](#)

Running Tallies

Near-Earth Objects Discovered

THIS MONTH: 36
THIS YEAR: 226
ALL TIME: 10804

Minor Planets Discovered

THIS MONTH: 1228
THIS YEAR: 8332
ALL TIME: 636415

MPEC 1996-K01 : 1996 JA1

The following *Minor Planet Electronic Circular* may be linked-to from your own Web pages, but must not otherwise be redistributed electronically.

A form allowing access to any MPEC is at the bottom of this page.

[◀ Read MPEC 1996-J07](#) [▶ Read MPEC 1996-K02](#)

M.P.E.C. 1996-K01 Issued 1996 May 16, 22:59 UT

The Minor Planet Electronic Circulars contain information on unusual minor planets and routine data on comets. They are published on behalf of Commission 20 of the International Astronomical Union by the Minor Planet Center, Smithsonian Astrophysical Observatory, Cambridge, MA 02138, U.S.A.

BMARSDEN@CPA.HARVARD.EDU or GWILLIAMS@CPA.HARVARD.EDU

1996 JA1

Observations:

J96J01A	1996 05 14.35091	15 48 36.15	+16 49 34.0	16.5 V	693
J96J01A	1996 05 14.36925	15 48 32.96	+16 49 34.0		693
J96J01A	1996 05 16.21042	15 42 51.45	+16 48 17.4	14 V	693
J96J01A	1996 05 16.22095	15 42 47.88	+16 48 16.5		693
J96J01A	1996 05 16.26477	15 42 31.50	+16 48 16.9	15.1 R	691
J96J01A	1996 05 16.26895	15 42 30.00	+16 48 17.2		691
J96J01A	1996 05 16.27398	15 42 28.08	+16 48 16.9		691
J96J01A	1996 05 16.28023	15 42 25.71	+16 48 16.2		691
J96J01A	1996 05 16.31087	15 42 13.81	+16 48 09.8		693
J96J01A	1996 05 16.41015	15 41 34.54	+16 47 40.6		693
J96J01A	1996 05 16.91436	15 38 29.75	+16 44 21.5	15.1 R	046
J96J01A	1996 05 16.91601	15 38 28.87	+16 44 21.1		046
J96J01A	1996 05 16.91686	15 38 28.42	+16 44 20.6		046
J96J01A	1996 05 16.91881	15 38 27.39	+16 44 20.1		046

Observer details:

046 Kitt. Observers J. Ticha, M. Ticha, Z. Moravec. 0.57-m f/5.2 reflector.

691 Steward Observatory, Kitt Peak. Observers C. W. Hergenrother, S. M. Larson, V. Hansen. Measurers C. W. Hergenrother, J. V. Scotti.

2.1-5 f/2 reflector.

693 Catalina Station, Tucson. Observers C. W. Hergenrother, T. Spahr. Measurer T. Spahr (discoverer). 0.41-m f/3 Schmidt.

Orbital elements:

1996 JA1

Epoch 1996 Apr. 27.0 TT = JDT 2450200.5 Marsden

M 344.09901	(2000.0)	P	0
n 0.24592611	Peri. 245.94759	+0.51172785	+0.79630616
a 2.5230912	Node 58.76165	-0.58509259	+0.59791046
e 0.6960932	Incl. 22.16223	-0.62912738	+0.09164927
P 4.01	H 5	G 0.15	U 8

From 12 observations 1996 May 14-16, mean residual 0".43.

Incoming observations via email & curl

LOTS of personal emails

Outgoing designation emails

Relational Database as well



What's the International Asteroid Warning Network?

IAWN suggested by UN GA

Committee on the Peaceful Uses of Outer Space
established 'Working group on NEOs'

'Action Team 14' suggested establishment
of IAWN by linking already-existing NEO
programs, such as the MPC, active survey teams,
and ESA, University of Pisa, etc.



Functions of International Asteroid Warning Network (IAWN)



- ✓ (a) To discover, monitor, and physically characterize the potentially hazardous NEO population using optical and radar facilities and other assets based in both the northern and southern hemispheres and in space;
- ✓ (b) To provide and maintain an internationally recognized clearing house function for the receipt, acknowledgement and processing of all NEO observations;
- ✓ (c) To act as a global portal, serving as the international focal point for accurate and validated information on the NEO population;
- ✓ (d) To coordinate campaigns for the observation of potentially hazardous objects;
- ❑ (e) To recommend policies regarding criteria and thresholds for notification of an emerging impact threat;
- ❑ (f) To develop a database of potential impact consequences, depending on geography, geology, population distribution and other related factors;
- ❑ (g) To assess hazard analysis results and communicate them to entities that should be identified by Member States as being responsible for the receipt of notification of an impact threat in accordance with established policies;
- ❑ (h) To assist Governments in the analysis of impact consequences and in the planning of mitigation responses.



(IAWN) “Needs List”

Dedicated groundbased telescopes capable of surveying to $V > 22$

Dedicated groundbased telescopes for astrometric and physical observation follow-up to $V > 22$

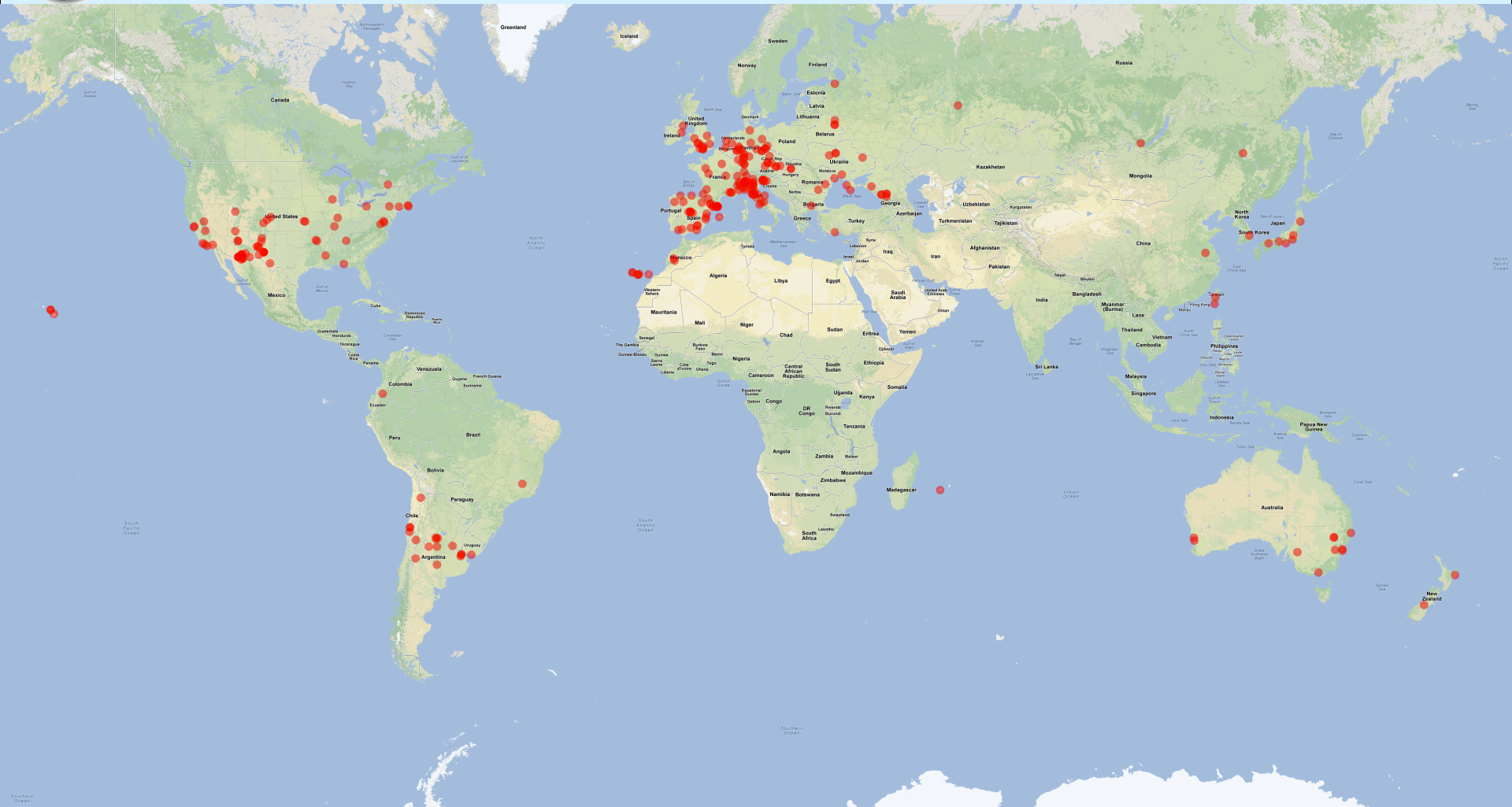
Spacebased infrared survey

Survey cooperation and collaboration

International communication and public relations with respect to potential impacts and their consequences



Existing Worldwide Observing Network



46 Countries submitted data, but 95% comes from just a few teams



Areas of Little Need

More groundbased telescopes that can only observe small patches of sky to $V < 20$

Poor-quality groundbased follow-up of NEOs to $V \sim 19-20$

The reason is that much of this is done by the survey telescopes now, at least in the northern Hemisphere



The Amateur Contribution

While amateur (read unfunded expert!) astronomers no longer discover many NEOs, they still make valuable contributions

- follow-up for orbital improvement & physical observations (radar, etc)

- lightcurves for shapes and photometry for phase functions & rough compositions

- orbit calculations (!); COMMUNICATION



The Future of NEO surveying

CSS is upgrading to 10-K monolithic CCDs and a focal reducer for MLS/G96 1.5m

Pan-STARRS full time this month (!) on the first telescope

ATLAS and LSST far and really far in the future

Space-based infrared system (NEOCam, Sentinel) would be spectacular, possibly operate before LSST



Summary and Conclusions



The MPC is the nerve center of worldwide asteroid observations, and a key node of the International Asteroid Warning Network

NEO discovery and tracking has reached wide importance

Many projects are improving detection and will discover more and smaller objects in the near future

Expect this to be an exciting and dynamic field!



Questions?